(4)

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : G06K 1/12, 7/10	A1	(11) International Publication Number: WO 89/07302 (43) International Publication Date: 10 August 1989 (10.08.89)

(21) International Application Number: PCT/GB89/00078

(22) International Filing Date: 27 January 1989 (27.01.89)

(31) Priority Application Number: 8802054

(32) Priority Date: 29 January 1988 (29.01.88)

(33) Priority Country: GB

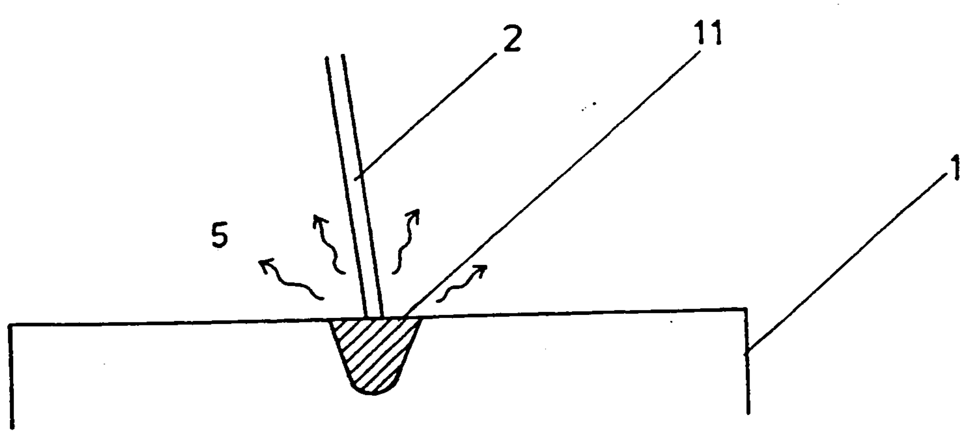
(71)(72) Applicant and Inventor: BAUGH, Joseph, John [GB/GB]; 172 Pontefract Road, Cudworth, Barnsley, South Yorkshire S72 8BE (GB).

(74) Agents: BILLINGTON, Lawrence, Emlyn et al.; Haseltine Lake & Co., Hazlitt House, 28 Southampton Buildings, Chancery Lane, London WC2A 1AT (GB).

(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: METHOD OF MARKING AN OBJECT USING A LASER BEAM, AND METHOD AND DEVICE FOR USE IN READING A MACHINE-READABLE DATA MARKING



(57) Abstract

A layer of a material transmissive of a laser beam or light beam is used to facilitate laser beam marking of objects and/or reading of machine-readable data markings previously formed on an object. In the laser beam marking method of the invention, the layer (3) of material is applied over a region of the object (1) to be marked and a laser beam (2) scans through the layer in a predetermined pattern to form a visible mark on the object. The layer of material facilitates formation of a distinct mark by the laser beam on various metals and other materials. In the reading method of the invention, the layer of material is held in contact with or in proximity to an object having a machine-readable data marking on a reflective surface, and the data marking is scanned by a light beam through the layer. The layer of material cuts down direct reflections from the reflective surface and hence improves the readability of the data marking. A device for use in reading a machine-readable data marking is also disclosed. The invention is of particular benefit in relation to marking of bar codes on metal surfaces.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland				

METHOD OF MARKING AN OBJECT USING A LASER BEAM, AND METHOD AND DEVICE FOR USE IN READING A MACHINE-READABLE DATA MARKING

The present invention relates to a method of marking an object using a laser beam, for example a method of laser etching of machine-readable data markings such as bar codes onto a metal tag or other metal object, and to a method and device for reading machine-readable data markings.

Attempts have been made in the past to mark metal surfaces using a laser beam (so-called laser etching), in particular by marking bar codes for identification purposes, for example on metal tags for attachment to car bodies in a car assembly plant. Such marking has in the past been effected by directing a laser beam directly onto the surface of a metal object to be marked. It is found that in order to produce a satisfactory mark, that is a bar code sufficiently distinct to be read by a bar-code reader, a high laser power and/or long duration of exposure must be used. The burning effect of the laser beam on the metal surface can in some cases burn right through the metal, and this is unsatisfactory when for example the metal object is a container or structural member of some kind. Moreover, laser exposure equipment is costly to run and so laser etching by this method (necessitating a high power or long duration exposure) is expensive. Certain metals, and other materials, are at present considered unsuitable for laser etching of bar codes even using a high power/long duration exposure.

According to a first aspect of the present invention, there is provided a method of marking an object using a laser beam, comprising the steps of:

covering a portion of the surface of the object to be marked, by a layer of a material which is

transmissive of the laser beam; and

scanning the laser beam over the covered portion of the object in a predetermined pattern, the scanning rate and beam power being chosen such that a visible mark is made on the surface of the object through the material in the predetermined pattern.

Preferably, the surface is made of metal. In general, however, the surface may be of any material which when etched by a laser beam forms a relatively dark mark. This applies, for example, to certain plastics.

The material transmissive of the laser radiation may be, for example, any of the following: self-adhesive tape, plastics film, perspex, or glass.

Preferably, a layer of adhesive is provided between the material and the surface of the object, and the material is adhered to the surface. The material and adhesive may conveniently be provided in the form of self-adhesive tape.

The predetermined pattern may be a machine-readable data marking, for example a bar code, and in this case "visible mark" refers to a mark of sufficient contrast relative to the unmarked surface to be read by reading apparatus for the data marking (e.g. bar-code reader).

The layer of material may be retained after marking, or it may be removed. In the case of a machine-readable data marking, it is preferable to retain the material over the marking since, being transmissive to the laser radiation of the marking beam, it will not in general impede reading by reading apparatus such as a bar code reader using laser radiation. On the contrary, it is found that the presence of the layer actually improves the readability of a data marking when marked on a reflective surface,

by reducing the amount of direct reflections reaching the detector of the reading apparatus. This effect also occurs with pre-existing markings, formed by methods other than that of the first aspect of the invention.

Thus, according to a second aspect of the present invention, there is provided a method for reading a machine-readable data marking using a light beam, the data marking having been marked on a reflective surface, comprising:

providing, in contact with or in proximity to the reflective surface, a layer of a material which is transmissive of the light beam and which directly reflects the beam to a lesser extent than the reflective surface;

scanning the light beam across the data marking through the layer; and

detecting light reflected from the reflective surface;

whereby the layer acts to reduce detection of direct reflections of the light beam.

The layer is preferably provided at a distance of between 0 and 20 mm from the reflective surface. The layer may be placed in position either before the data marking is marked or afterwards ; in either case the layer is conveniently provided in the form of a self-adhesive film or sheet which is adhered to the reflective surface.

According to a third aspect of the present invention, there is provided a device for use in reading a machine-readable data marking, comprising:

an object having such a data marking marked on its surface; and

a layer of a material which is transmissive of a light beam used in reading apparatus for the data

marking, but which produces less direct reflections of that beam than the bare surface of the object, the layer being provided over the data marking in contact with or in proximity to the object, whereby the readability of the data marking is improved.

In the above second and third aspects of the invention, the machine-readable data marking may comprise a bar code.

Reference is made, by way of example, to the accompanying drawings in which:

Figure 1 illustrates an example of a conventional method for marking an object using a laser beam;

Figure 2 illustrates an example of a method of marking an object in accordance with the first aspect of the present invention;

Figure 3 illustrates results obtained using the conventional marking method; and

Figure 4 illustrates results obtained using a method exemplifying the first aspect of the invention.

As shown in Figure 1, in a conventional laser marking (etching) method, the surface of a metal object 1 is directly irradiated with a laser beam 2. The laser radiation causes local heating and vapourisation in a region 11 of the metal surface in and immediately adjacent the exposed region, generating vapours which escape into the atmosphere as indicated at 5. The exposed region of the metal is changed in texture compared with the unexposed parts of the surface, and for example when the unexposed surface is bright and shiny, the exposed parts appear somewhat darkened in comparison. This allows a visible and permanent marking to be made in the metal surface, and when the laser beam is scanned in a predetermined pattern, a desired bar code, words or numerals can be formed.

However, in order to form an acceptably visible marking, for example a bar code of sufficient contrast relative to the unexposed surface to be read by a bar-code reader, a high power and/or long duration of exposure is required, penetrating deep into the metal as indicated by 11 in Figure 1. This can weaken the object and in any case makes the marking expensive to perform, since the laser beam exposure equipment is costly to run. Consequently, laser marking is at present unsuitable and/or uneconomic for many potential applications.

The inventor of the present invention has discovered that, by covering the surface to be exposed by a layer of a material transmissive of the laser radiation, satisfactory marking can be obtained with less exposure of the surface, that is with a less powerful beam and/or a faster scanning rate.

Figure 2 shows an example method of exposing a metal surface, such as a metal tag to which a bar code is to be applied. As shown in Figure 2, a layer of the transmissive material 3 is placed in close contact with the metal surface 1. The laser beam 2 passes through the layer of material 3, to the metal surface. Since the layer 3 is transmissive of the laser radiation, i.e. allows the laser beam to pass through without significant absorption, it is largely unaffected by the laser beam and remains in position over the metal surface. As before, however, local heating and vapourisation takes place in a region 12 of the metal surface. Under the heat generated in region 12, the layer 3 may expand slightly over this region (depending on its composition). Due to the lower amount of laser beam exposure, the region 12 is smaller, in particular shallower, than in the conventional method and yet it is found that a dark mark is left relative to the

unexposed regions.

The reason for this is thought to be that the vapours generated in the exposed region are no longer free to escape to the outside atmosphere, but are trapped under the layer 3, and consequently recombine with the molten metal in region 12 forming oxides which appear much darker than the surrounding unexposed metal. Thus, the mark is apparently formed not simply by a change in surface texture as for etching of bare metal, but a chemical change in the surface region of the metal.

The amount of reduction in laser power, compared with conventional methods, enabled in this way may for example be 40% or more. This corresponds to a power of under 20W required to mark most metal surfaces.

This effect has been found to occur with several metals including aluminium, zinc, copper, brass, all types of steels, and lighter (whiter) grades of cast iron. However, the effect need not be confined to metals as already mentioned.

For the purpose of testing the above method, an industry standard 60 watt CW/switched multimode YAG laser engraving machine was used. The machine was equipped with Q-switching, a 12/20 beam expander and a 160 mm flat field object lens. Beam directional control was obtained by X, Y axis galvanometer mounted mirrors. The whole system was controlled by a force computer with input via a terminal screen and keyboard.

For tests, a four character interleaved 2 of 5 bar code type was used. As is common practice, the code numbers were marked in text beneath the bar code, the whole being constructed by the machine's software in the usual manner. The bar code was etched using a final beam diameter of 0.01mm hereinafter called the

"beam spot". The beam spot was moved in such a way as to build up the bars of the code from vertical lines 0.01 mm wide, the lines being marked parallel and next to each other.

The speed at which the laser spot was moved in an X,Y direction while marking is hereinafter called the "marking speed". The term "transition" below refers to the time during which the beam spot was not marking but moving between one line or bar, text character and another. While in transition the beam was moved at its maximum speed of 1000mm/second, hereinafter called the "transition speed". The total transition time used in marking the codes and text per mark was typically less than 0.03 seconds.

To mark metal using the conventional method (i.e. without any covering layer) with a code constructed as described, a marking speed of around 5mm/second was found to give the best results. Increasing this speed to 10 mm/second was found to have a noticeably deleterious effect and as speed increased, the black bars of the code faded, until at around 30mm/second the bars had faded sufficiently to prove difficult to read using a bar code reading device. This was found to be the case with a variety of metals generally accepted as being able to be marked using this conventional method.

A four character code 5mm in height by 19mm wide constructed using 163 vertical lines and marked at 5mm/second would take a total of 163.03 seconds for marking to be completed. At a speed of 10mm/second it would take 81.53 seconds to complete the mark, impractical for almost every industrial application.

However, using the method of the present invention, the marking speed can be increased. A marking speed of 80mm/second was used to mark bar codes

onto a number of metal types. The codes were constructed as before with the exception that the code was 10mm high and 19mm wide and a covering layer was provided as described above. The marks were completed in 14.94 seconds, 14.41 seconds to mark the code and 0.53 seconds to mark the characters "1989" beneath the code, transition time included. Further tests have shown that non-ferrous metals can continue to be marked at much higher speeds, typically 200 to 400mm/second. At these speeds the code and text can be marked on aluminium within 3.0 seconds. In one instance codes were marked onto anodised aluminium and still found to be fairly readable at speeds up to 900mm/second and taking less than 1.5 seconds to mark.

The table below lists a variety of materials that were marked in the tests using the method of the invention. They were all marked with a 10mm high by 19mm wide 4 character bar code, underneath the code number 1989 was marked in 1.8mm high text using a marking speed of 80mm/second.

Bar codes pre-printed on supermarket goods picked at random were used as control samples. These indicate how well the metal marked codes compare with paper printed labels.

TABLE

MATERIAL	READABILITY PERCENTAGE	RANGE OF FOCUS IN cm	TYPICAL READ ANGLE IN DEGREES
1. MARKED USING THE INVENTION			
Anodised Aluminium	100	43	52
Aircraft Aluminium 'Dural L163'	97	30	23
Aluminium NS4	99	46	28
Clock Brass	100	56	18
Stainless Steel	100	43	12
Stainless Steel 'Type 316'	99	25	22
Copper Pipe	100	51	6
Zinc	97	48	5
2. CONTROL SAMPLES			
Kodak Film Packet	100	20	50
Heinz Salad Cream	78	18	31
Kelloggs Corn Flakes	43	10	23
Kelloggs Bran Buds	64	18	36
Smedleys Tinned Garden Peas	17	13	17

The readability percentage indicates the average number of reading attempts required, e.g. 50% implies that two attempts will be required on average, 25% corresponds to four attempts, and so on. (However, this relationship breaks down at lower percentages : below 20% or so many attempts may be required). As can be seen from the above Table, the readability results attained on metal surfaces using the present invention compare favourably with those for everyday supermarket goods whose bar codes are required to be read by POS (point-of-sale) scanners, light pens, and the like. This confirms that bar codes marked on metal surfaces by the present invention can be read by bar code readers in common use without requiring more sensitive, specialist equipment. The readability figures in the Table are all based for "bare" bar codes, that is, the tape used to enhance the etching was removed before testing the readability.

The difference between the readability of laser-etched markings obtained with and without the first aspect of the invention, all other conditions being equal, can be readily appreciated by comparing Figures 3 and 4.

Figure 3 shows a bar code and some text etched onto a piece of sheet aluminium without using any covering. Figure 4 shows the same markings etched onto an identical piece of aluminium under the same etching conditions (power, marking speed and so forth) but with a layer of transparent self-adhesive tape applied to the surface in accordance with the first aspect of the invention. (The words "WITHOUT" and "WITH" respectively were applied afterwards with a ballpoint pen). The difference in legibility between the two, as picked up by a photocopying machine, which uses a similar type of scanning to many bar code readers, is

self-evident.

The range of focus in the Table refers to the distance range along the reading beam within which the bar code can be successfully read. The light beam scanning the bar code has a focal point at which the bar code should ideally be placed, but the reading apparatus can tolerate a range of positions around this focal point. Clearly, the longer the range of focus, the better.

The read angle is the angular range within which the beam can strike the bar code (which of course is normally flat) whilst still allowing a successful read. Again, the larger this range, the better. For certain metals this range is relatively restricted, due to their particualr reflective properties.

Although the highest attainable marking speed appeared to be around 400mm/second for a large number of the metals tested, and an upper limit was being met with anodised aluminium at 999mm/second, this merely reflected the upper limit of the test apparatus itself. Indications are that with more power available, the speed of marking may be extended well beyond those figures. In fact 80 mm/second is the lower limit for marking using Sellotape (RTM) and similar coverings, because at slower speeds the tape itself burns through.

The test machine's upper speed limit of 999mm/second is set by the maximum speed at which the galvanometer mirrors can be moved (the speed that the laser beam can be moved around the surface of the target material).

Extrapolating from the above results, it appears that a machine of 120 watts laser power would have a lower limit on marking speed of around 160mm/second when using covering tape, with a band between 400-800 mm/second for most metals. The marking

time for a bar code can be calculated as follows:

Marking time = No. of lines per code x code height (mm) ÷ Marking speed (mm/second) + transition time (e.g. 0.03 seconds).

So, for example, the marking time for a 163-line x 10 mm high bar code at 800 mm/second marking speed is:-

163 x 10mm ÷ 800mm/second = 2.0375 + 0.03 = 2.0675 seconds (marking time)

If the mirror speed is increased beyond 1 metre/second, say to 2 metre/second then the transition time is reduced to 0.015 seconds.

Such short marking times have not been considered possible before, when etching bar codes onto metals and the like, and enable bar code marking in previously uneconomical applications.

The above figure of 163 lines for the 4 character 19 mm wide bar code represents a desired minimum. In fact it represents 9.6mm as bars and 9.4 mm as spaces. This means that the bars are constructed of 14.16 lines (0.01mm wide) per mm. In fact the more lines per mm (up to a point) the darker the bar. Tests show that it is desirable to have no less than 30 lines per mm, (where time allows), which would of course affect the marking time.

Nevertheless, the test results establish that the marking time required when using the present invention can be drastically reduced compared with the conventional method, and indeed the present invention makes bar coding of certain metals practical for the first time, particularly non-ferrous metals and alloys.

After the completion of laser beam exposure using the above-described method, the resulting markings are clearly visible through the layer 3, so this layer 3 can be retained if desired. Indeed, in

the case of forming bar codes or other type of data marking on reflective surfaces such as metal surfaces, it is positively advantageous to retain the layer 3. This is because it is found that readability of the bar code by bar code readers is actually improved by the presence of the layer. This leads to the second and third aspects of the invention as explained below.

In other applications, however, it will be preferable to peel off the layer 3 which is then simply discarded.

Since, for example, ordinary clear adhesive tape (e.g. Sellotape (RTM)) can be used to provide the layer 3, the present invention is extremely cheap and easy to implement. Other materials can also be used to provide the layer 3, such as transparent plastics films, perspex and glass. For awkwardly-shaped objects, it is possible to vacuum-shrink a film of polythene or the like onto the object to provide the layer 3. It is desirable, for maximising the effect of the first aspect of the present invention, for the layer 3 to be in as close contact as possible with the metal surface, and for this reason a flexible film vacuum shrunk or adhered with an adhesive is preferred. The layer 3 need not be completely visually clear but may be translucent, tinted or coloured, so long as laser radiation of the kind transmitted by laser beam exposure equipment is transmitted well. Such equipment may for example use a YAG or CO_2 laser.

As already mentioned, when the above-described method is used to form machine-readable data markings such as bar codes, the resulting markings are highly suitable for reading by laser scanning equipment of the kind used to read conventionally laser-etched bar codes and the like. However, the readability can be further improved.

The second and third aspects of the present invention will now be explained.

Bar code reading apparatus employs a process similar to a conventional etching process, that is, a light beam is scanned over the bar code and the variation in reflected light is used to read the code. Some types of bar code reading apparatus, such as light pens sometimes used at supermarket checkouts, employ a light beam produced by one or more light-emitting diodes (LEDs). Other types of reading apparatus utilise a laser beam similar to that used for laser etching but of much lower power (of the order of milliWatts rather than Watts) such as a He-Ne laser.

In any case, the reading beam scans the bar code and reflected light from the bar-coded surface is picked up by a photodiode or other optical detector. The detector is used to determine dark or light (absent) bands in the bar code on the basis of diffused light from the surface, rather than direct reflections. Direct reflections from the surface are to be avoided, as these "swamp" the detector and reduce the readability of a bar code marked on a reflective surface such as a metal surface or glossy painted or printed surface.

It is found that with a layer of transmissive material in position over the surface, either in close contact with (e.g. adhered to) or in proximity to the surface, the amount of direct reflected light reaching the detector is reduced and hence reading can be performed more reliably. As an example, a bar code marked on a highly reflective surface which normally gives only 20% readability (consequently requiring, on average five scanning attempts to produce a successful read), is found to give 60% readability when covered by a layer of polythene.

Of course, the maximum readability in any case is 100%, and in cases where the bar code already has a high readability, the improvement gained by adding or retaining a transmissive layer may only be small

There is a limit to how far the layer can be positioned from the surface whilst providing an advantageous effect. If it is placed too far away, the incoming light beam is diffused to an undesirable extent and no longer scans the bar code precisely enough. The preferred range of positioning for the layer is between 0 and 20 mm from the reflective surface.

The most effective material so far identified for use in the second and third aspects of the invention, is Scotch (TM) Magic 810 tape manufactured by the 3M company. This material is also satisfactory for enhancing laser etching in accordance with the above-described first aspect.

It will be noted that the use of a layer of transmissive material in this way is applicable to bar codes on any reflective surface and is not confined to surfaces suitable for marking by the method of the first aspect of the invention. The bar codes need not have been laser etched but may have been painted or printed.

Moreover, any suitable light beam can be used as the reading beam. In this context the expression "light beam" includes any kind of electromagnetic radiation, not just visible light.

The present invention is of particular benefit in the automobile industry, in which metal tags are attached to car bodies during assembly on production lines. These metal tags are bar-coded for identifying the particular car model which each body is destined to become. By use of a preferred example of the methods

of the present invention, the tags can be bar-coded and then read whilst retaining a layer of self-adhesive transparent tape. Subsequently, in the paint shop, the car body is sprayed all over with paint and normally the code on its tag would be covered too. Using tape, however, the self-adhesive tape can simply be removed after spraying to expose the bar code once again. In this way the bar code can be preserved for assisting subsequent work, without needing to be specially protected from paint or replaced after painting.

The advantages of the present invention will be apparent.

By virtue of the first aspect of the invention, because the affected region under laser beam exposure is relatively shallow, the amount of damage to the metal is reduced and moreover the affected region turns out slightly narrower, allowing improved definition of the patterns to be marked.

Since the required exposure for a readable marking (e.g. a machine readable data marking) is less, the scanning rate can be increased, allowing the markings to be formed more quickly so that the expensive laser beam exposure apparatus is utilised more efficiently. The cost of marking objects in this way is hence reduced and it is thought that the method of the present invention could be used in a wide variety of marking applications for information and decorative purposes.

One envisaged application is in the etching of brassware. The laser beam exposure apparatus is readily controlled by computer, and hence by programming a desired pattern, series of words, or the like into a computer a corresponding etching could be produced completely automatically. Since computers can manipulate any digital information, a digitised image

could be fed in and used to drive the laser beam in order to produce decorative effects quite unobtainable by other means.

By virtue of the second and third aspects of the present invention, the readability of machine-readable data markings, including bar codes, formed on reflective surfaces can be improved in an extremely simple and inexpensive way.

To summarise therefore, in the present invention a layer of a material transmissive of a laser beam or light beam is used to facilitate laser beam marking of objects and/or reading of machine-readable data markings previously formed on an object.

In the laser beam marking method of the invention, the layer of material is applied over a region of the object to be marked and a laser beam scans through the layer in a predetermined pattern to form a visible mark on the object. The layer of material facilitates formation of a distinct mark by the laser beam on various metals and other materials.

In the reading method of the invention, the layer of material is held in contact with or in proximity to an object having a machine-readable data marking on a reflective surface, and the data marking is scanned by a light beam through the layer. The layer of material cuts down direct reflections from the reflective surface and hence improves the readability of the data marking. A device for use in reading a machine-readable data marking is also disclosed.

The invention is of particular benefit in relation to marking of bar codes on metal surfaces.

CLAIMS:

1. A method of marking an object using a laser beam, comprising the steps of:

covering a portion of the surface of the object to be marked, by a layer of a material which is transmissive of the laser beam; and

scanning the laser beam over the covered portion of the object in a predetermined pattern, the scanning rate and beam power being chosen such that a visible mark is made on the surface of the object through the material in the predetermined pattern.

2. A method as claimed in claim 1, in which the material transmissive of the laser radiation comprises one of the following materials: self-adhesive tape, plastics film, perspex, and glass.

3. A method as claimed in claim 1, in which a layer of adhesive is provided between the material and the surface of the object, and the material is adhered to the surface.

4. A method as claimed in claim 3, in which the material and adhesive are provided in the form of self-adhesive tape.

5. A method as claimed in any preceding claim, wherein the predetermined pattern is a machine-readable data marking.

6. A method as claimed in claim 5, wherein the material over the marking is retained for use in subsequent reading of the marking by reading apparatus.

7. A method as claimed in claim 5, wherein the machine-readable data marking comprises a bar code.

8. A method for reading a machine-readable data marking using a light beam, the data marking having been marked on a reflective surface, comprising:

providing, in contact with or in proximity to the reflective surface, a layer of a material which is

transmissive of the light beam and which directly reflects the beam to a lesser extent than the reflective surface;

scanning the light beam across the data marking through the layer; and

detecting light reflected from the reflective surface;

whereby the layer acts to reduce detection of direct reflections of the light beam.

9. A method as claimed in claim 8, wherein said layer is provided in the form of a self-adhesive film or sheet which is adhered to the reflective surface.

10. A method as claimed in claim 8, wherein said layer is provided at a distance of between 0 and 20 mm from the reflective surface.

11. A method as claimed in claim 8, wherein said layer is placed in position prior to marking the data marking on the reflective surface.

12. A method as claimed in claim 8,9,10 or 11, wherein the machine-readable data marking comprises a bar code.

13. A device for use in reading a machine-readable data marking, comprising:

an object having such a data marking marked on its surface; and

a layer of a material which is transmissive of a light beam used in reading apparatus for the data marking, but which produces less direct reflections of that beam than the bare surface of the object, the layer being provided over the data marking in contact with or in proximity to the object, whereby the readability of the data marking is improved.

14. A device as claimed in claim 13, wherein the machine-readable data marking comprises a bar code.

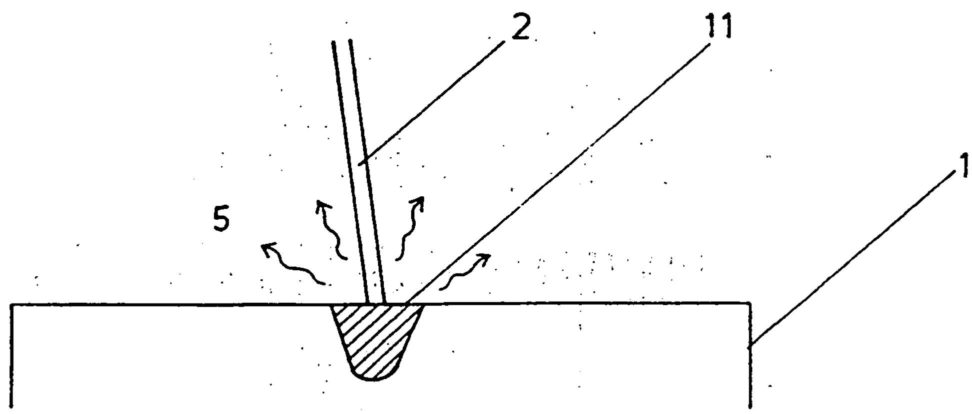


FIG. 1

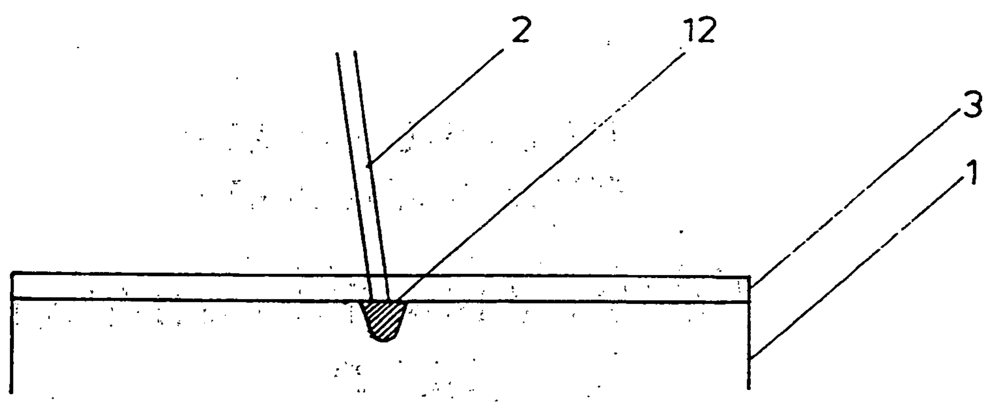


FIG. 2

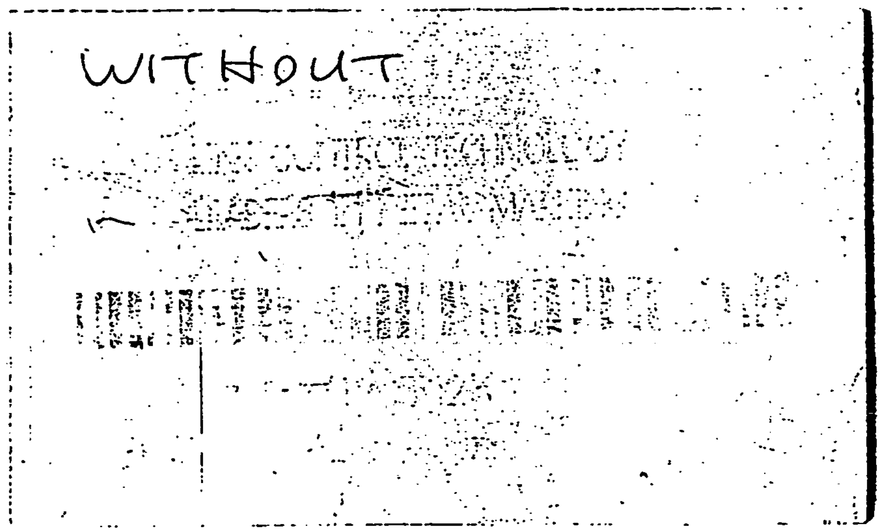

WITHOUT

FIG. 3

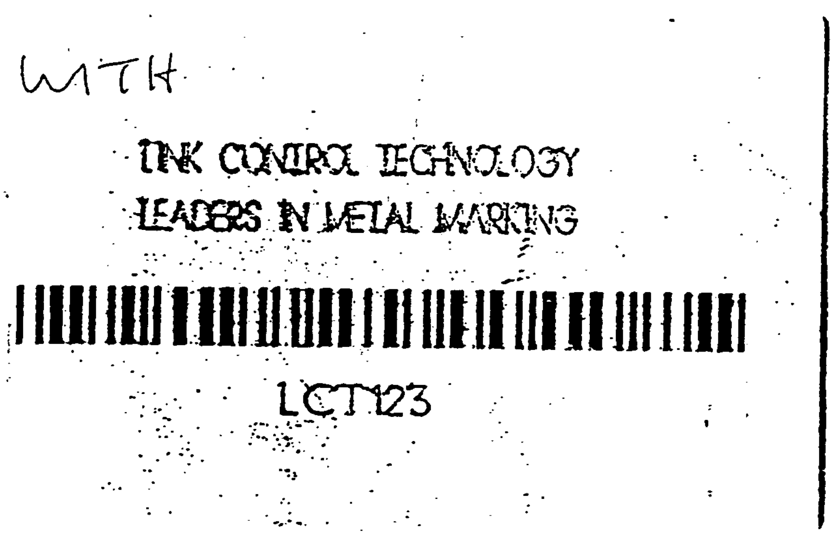

WITH
INK CONTROL TECHNOLOGY
LEADERS IN METAL MARKING
LCT123

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 89/00078

I. CLASSIFICATI N F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC4: G 06 K 1/12, 7/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC4	G 06 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 4500777 (J. DREXLER) 19 February 1985, see column 2, line 36 - column 3, line 25; figures 1-4; claims 1-3 --	1,2,5-8, 10-14
A	US, A, 3958253 (B. RUECKMANN) 18 May 1976, see the whole document --	1
A	US, A, 3858031 (J.P. KORNFELD) 31 December 1974, see abstract; figures 1-5 --	8,13
A	US, A, 3849632 (A.B. ECKERT) 19 November 1974, see abstract; figure 1 --	8,12-14

----

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25th April 1989	17.05.89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/GB 89/00078

SA 26965

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 03/03/89
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4500777	19/02/85	US-A- 4544835	01/10/85
		WO-A- 82/02969	02/09/82
		EP-A- 0072854	02/03/83
		AU-D- 82725/82	14/09/82
		US-A- 4542288	17/09/85
		AU-A- 549957	20/02/86
		US-A- 4609812	02/09/86
		US-A- 4680460	14/07/87
		US-A- 4680456	14/07/87
		US-A- 4680458	14/07/87
		US-A- 4683371	28/07/87
US-A- 3958253	18/05/76	DE-A- 2346923	27/03/75
US-A- 3858031	31/12/74	FR-A-B- 2218596	13/09/74
		DE-A- 2407984	29/08/74
		GB-A- 1453781	27/10/76
		CA-A- 1011876	07/06/77
		CH-A- 589896	29/07/77
		JP-A- 49119547	15/11/74
US-A- 3849632	19/11/74	FR-A- 2190298	25/01/74
		DE-A- 2330759	10/01/74
		GB-A- 1414830	19/11/75
		CA-A- 999971	16/11/76

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82